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X-RAY DIFFRACTION STUDY OF THE STRUCTURE OF OXIDE CATHODES,(U)
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By

V. D. Hrebenyuk, I. V. Kavitch, et al

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X-RAY DIFFRACTION STUDY OF THE STRUCTURE OF OXIDE CATHODES

V. D. Hrebeniuk, I. V. Kavitch, V. P. Palivoda, I. T. Romanychok

The ratio of the oxide cathode phases is of great importance in studying the physico-chemical processes which occur in the oxide cathodes when they function. Studies of the thermoelectronic emissions in modern electro-vacuum apparatus [1,2] have shown that they are not only dependent on the ratio between BaO and SrO (in cathode ray tubes (CRT) 42 percent SrO and 58 percent BaO), but on a number of other factors, which change in the presence of free barium, and on the effects of the crystal lattice, which evolves during the formation of free barium. In this connection, X-ray diffraction study of the structure of the oxide cathodes, i.e., an explanation of the state and reciprocal action between the oxides of alkali earth metals in oxide coatings, is of interest.

Work [3] showed that a continuous sequence of solid solutions is formed at the SrO-BaO interface. The constant of the crystal lattice increases linearly with the increase in the concentration of BaO (Vegard's law operates).

Using the data in [3], the task in this work was to study the structure of the oxide coating of CRT as a function of the working regime and the length of service.

Let us note that several circumstances make X-ray diffraction studies of the structure of an oxide coating of a CRT difficult. First of all there is the interaction between the oxide layer and the atmosphere (steam, oxygen, CO_2, etc.), which leads to the formation of hydrates of $Ba(OH)_2$ and $Sr(OH)_2$, and it was indispensable to carry out this study in either a vacuum or an inert atmosphere.

In connection with the fact that the first method of X-ray diffraction study is quite unfeasible, we chose the second. A CRT was placed in a dry vacuum chamber, especially prepared for these studies; the air was evacuated from the chamber, it was scrubbed with pure argon, and then cathodes were taken from

the CRT in the inert atmosphere. In order to protect the oxide layers against interaction with the atmosphere, they were covered with a thin layer of paraffin. This made it possible to make X-ray diffraction studies of the structure of the oxide layer in the atmosphere.

An X-ray film was made on the URS-55a apparatus with a copper anticathode (BCV-2 tube, intensity 35kw, current 15 ma, exposure time 3.5 hours). The X-rays were made in a RKU-114 camera with the polished film method. A lining, similar to that on which the oxide coatings were made, was used as a standard.

Analysis of the experimental results show that the oxide coating on the CRT is of a single phase, with a crystalline structure (face-centered cubic lattice) dependent on the working regime and the length of service of the CRT. The table provides data on the phase composition of the oxide layer (i.e., solid Ba(Sr)O solutions) as a function of the working regime and the length of CRT use.

As can be seen from the table, in the CRT which were not functioning the ratio between the components of the solid solution of Ba(Sr)O (oxide coating) is composed of 58 percent BaO and 42 percent SrO. In the oxide covering of the cathodes which were used in a normal regime (U = 6.3 v, I = 50 ma), no significant changes are observed in the percentage composition (a small change in the percentage composition of the substances occurs in the CRT with a long period of service, for example in the CRT which worked for 5375 hours). Thus, in the oxide coating of cathodes which worked under a forced regime (U = 7.6 v, I = 50 ma), a reduction in the concentration of BaO is observed, which may be the basic cause of the decrease in thermoelectronic emission. Obviously under normal regimes other processes, particularly poisoning, play a greater role in aging.

It is necessary to mention that "craters" were found on the oxide layer in some CRT, as well as unequal phase distribution (BaO; SrO) on the surface of the cathode. Studies have shown that the percentage of BaO content in these CRT is considerably less (e.g., a CRT with "craters", functioning under a

forced regime, has a percentage composition of solid solution of Ba(Sr)O : 41 percent BaO and 59 percent SrO). The reason for the occurrence of the "craters" on oxide layers must obviously be considered their bombardment by heavy positive ions, leading to local overheating. This fact is probably associated with a different degree of dilution in the CRT and a different crystal size in the solid solution of Ba(Sr)O. A study of the conditions for the appearance of similar "craters" and processes associated with them may provide valuable information to explain the causes for the loss of thermoelectronic emission by oxide cathodes.

Characteristic CRT		Content, percentage	
Working regime	Hours worked	BaO	SrO
6.3 v, 50 ma	CRT not working	58	42
6.3 50	600	58	42
6.3 50	2,200	58	42
6.3 50	5,375	54	46
7.6 50	500	54	46
7.6 50	1,000	52	48
7.6 50	625*	41	59

Note: The precision of the percentage composition found with the X-ray diffraction method amounts to ± 1 percent.

*There is a "crater" on the surface of the oxide coating.

Summary

The work holds the reseach results of oxide cathode—structures of different working period and cathode-ray tube life—time. It has been shown that phase composition of oxide layer depends upon the term of performance and operatiog conditions of the tube.

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